

REMARKS:

- 1) In the acknowledgment copy of applicants' Information Disclosure Statement of March 14, 2005 enclosed with the prior Office Action dated June 15, 2009, the Examiner indicated "The PTO did not receive the following listed item(s) \*AF". See the stamped text at the bottom of page 1 of the acknowledgment copy of the IDS of March 14, 2005 and the Form PTO-1449 with an asterisk (\*) at reference AF, as enclosed with the Office Action dated June 15, 2009. The reference cited as "AF" is the article "Fabrication of thick silicon dioxide layers using DRIE, oxidation and trench refill" by C. Zhang et al. Contrary to the Examiner's indication, a copy of that reference was filed with our Supplemental IDS of February 28, 2008 (which was filed by telefax and received by the USPTO on the same date). Thus, please indicate that reference "AF" has been received and considered by returning a completely initialed, signed and dated acknowledgment copy of applicant's IDS Form PTO-1449 of March 14, 2005.
- 2) The specification has been amended on pages 3 and 5 to provide more-direct antecedent support in the written description for the present new claim terminology. The amendments in the specification are supported by the context of the original written description (for example at page 1 lines 3 to 8, page 2 lines 5 to 7, page 3 lines 3 to 7, and page 4 line 29 to page 5 line 7), and the drawing Figs. 7, 8, 9 and 10. Merely conforming the written description to the original drawings and clarifying

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the text of the original description do not introduce any new matter. Entry of these amendments is respectfully requested.

- 3) The prior claims have been amended editorially and formally to avoid certain issues of asserted indefiniteness. Namely, referring to page 2 of the Office Action, the rejection of claims 1 to 3 and 7 to 9 as indefinite under 35 USC 112(2) is traversed in view of the current amendment. The indefinite and relative terms pointed out by the Examiner have been avoided, because these expressions are not necessary for a proper understanding and definition of the claimed invention. Accordingly, please withdraw the indefiniteness rejection.
- 4) New claims 10 to 20 have been added. These claims have been drafted "from the ground up" as a fresh approach at covering inventive subject matter with somewhat different claim terminology, style and format in comparison to the prior claims that were based on a direct translation of the foreign-language PCT international claims. The new claims differ from the original claims in an effort to better comport with typical US claim style and practice. The new claims are supported by the original claims and the original disclosure as shown in the following table, and do not introduce any new matter. Entry and consideration of the new claims are respectfully requested.

new claims	10	11	12	13	14	15
original support	Cl 1, 7; Figs. 7, 8; P 1 L 3-8; P 2 L 5-7; P 3 L 3-7; P 4 L 29 - P 5 L 7	Cl 2	Cl 3	Cl 7; Fig. 10	Cl 8	Cl 9; P 2 L 20-24

  

new claims	16	17	18	19	20
original support	Cl 3; P 2 L 10-17; P 4 L 6-8, 16-20	Fig. 9	Figs. 7, 9	Figs. 9, 10; P 5 L 8-12	Figs. 5-9

- 5) Referring to pages 3 and 4 of the Office Action, the rejection of claims 1 to 3, 8 and 9 as anticipated by US Patent 5,426,070 (Shaw et al.) is respectfully traversed.

The invention of present claim 1 is directed to a process of fabricating an isolation structure for mechanically connecting (and electrically insulating) a functional structure with a semiconductor substrate. The process includes a step of forming two trenches spaced from each other in the semiconductor substrate, so as to form a rib remaining entirely between the trenches. A further step of the present invention of claim 1 involves converting the substrate material in the area of the trenches into an electrically insulating material comprising complete conversion of the rib between the trenches. The inventive method further includes a step of forming a functional structure within the substrate material, such that this functional structure is mechanically connected with the substrate exclusively by the converted substrate material formed in the area of the trenches. The Shaw et al. patent does not disclose such a method.

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Shaw et al. disclose a method of forming a "beam 50" which includes "a core 68 of single crystal silicon with oxide layers 12 and 60 on its top and side surfaces" and also includes "a thin region 52 wherein the silicon has been completely oxidized to form the isolating segment 66 which joins the adjacent sections 54 and 56 and also provides a mechanical supporting mechanism for the beam" (col. 14 lines 48 to 56). Shaw et al. aim to maintain a non-oxidized, non-insulating silicon portion as well as an oxidized portion in the beam, i.e. merely providing an isolating segment of completely oxidized insulating material while the rest of the beam still has a core of non-oxidized silicon (see col. 13 lines 18 to 37 and col. 13 line 60 to col. 14 line 35).

According to present claim 1, the "rib" is defined as that material "remaining entirely between the trenches". Claim 1 further requires complete conversion of the substrate material of the rib to the electrically insulating material. This is a significant distinction from the Shaw et al. disclosure. Namely, the "thin region 52" of Shaw et al. cannot be regarded as corresponding to the present rib, because that "thin region 52" does not extend entirely between the trenches. Rather, as identified by the Examiner, the "rib" includes the "thin region 52" as well as the "adjacent thick sections 54 and 56". However, it is clear from Shaw et al. that only the thin region 52 is completely converted to an insulating oxide, while the thick regions 54 and 56 adjacent to the thin region are only partially converted, i.e. only have outer oxide layers but retain a core of silicon (col. 14 lines 48 to 62). Therefore, Shaw et al. do

not disclose a step of "complete conversion of the entire rib" wherein the rib is defined as "remaining entirely between the trenches", and thus Shaw et al. do not anticipate the invention of claim 1. Furthermore, claim 1 would not have been obvious, because the resulting structure of Shaw et al. has mechanical and electrical functions required by Shaw et al. (see col. 14 lines 56 to 62). Thus, because Shaw et al. disclose the particular method steps for achieving particular mechanical and electrical functions, a person of ordinary skill in the art would not have been motivated and would have found no teachings toward achieving a successful and predictable result, by modifying the teachings of Shaw et al. to achieve the contrary method steps of the present invention.

An exemplary structure resulting from the inventive method is illustrated in present Figs. 5 to 9. A visual comparison of the method steps and structures disclosed by Shaw et al. (see Figs. 2, 5A and 5B), demonstrates the significant difference between the Shaw et al. method and the present inventive method. It is evident in those drawing figures, that the complete or entire "rib" in the Shaw et al. method (including thin and thick sections), is not completely converted into an insulating material, but rather includes a core of the original silicon material 10, 68 over substantial length portions of the rib (the thick portions).

For the above reasons, the invention of present claim 1 is not anticipated and also would not have been obvious over Shaw et al. The dependent claims are patentably distinguishable already due to their dependence. The Examiner is respectfully

requested to withdraw the anticipation rejection applying Shaw et al.

- 6) Referring to pages 4 and 5 of the Office Action, the rejection of claims 1 to 3 and 7 to 9 as anticipated by US Patent 5,628,917 (MacDonald et al.) is respectfully traversed.

Important features of present independent claim 1 have been discussed above. MacDonald et al. do not disclose and would not have suggested such a combination of method steps and features. Particularly, present claim 1 defines the rib as remaining entirely between the trenches, e.g. the rib includes the entirety of the material between the trenches. Present claim 1 further recites a step of complete conversion of the semiconductor substrate material of the entire rib into an electrically insulating material. Furthermore, the method of claim 1 involves a step of forming a functional structure within the substrate material, such that the functional structure is mechanically connected with the substrate exclusively by the substrate material that has been converted into insulating material at the trenches.

Contrary to these inventive features, MacDonald et al. disclose a method of forming a functional structure on a wafer, and then removing this functional structure with a supporting frame from the wafer, to be installed onto another substrate material to form a device or to be used as a mask (see col. 3 lines 53 to 64). Thus, the functional structure is not "formed within the substrate material" to which it is mechanically

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connected exclusively by the converted substrate material formed at the trenches.

More importantly, MacDonald et al. further disclose that the frame on which the functional structure is mounted includes suspended contact pads (i.e. remaining conductive portions) as well as oxide isolating segments (col. 4 lines 27 to 29). At a particular cross-section Fig. 1n shows a remaining part 32 of what the Examiner referred to as the rib 28, but this is only at one particular cross-section location, and does not apply to all cross-sections of this resulting frame rib, which includes both conductive material sections and oxide isolating sections (col. 4 lines 26 to 28). The make-up of this frame is crucial, because present claim 1 requires a step of completely converting the entire rib, which is the material remaining entirely between the trenches, and this converted material must be the exclusive mechanical connection with the substrate in which the functional structure is formed. However, the frame or rib of MacDonald et al. has a different make-up because the resulting frame purposely includes both conductive portions and isolating portions, and also this frame is then clipped and removed from the original substrate and then mounted on another substrate to form the device (col. 4 lines 28 to 41).

Because the MacDonald et al. patent relates to a method that is a further development of the method underlying the Shaw et al. patent, namely the SCREAM process (col. 3 lines 51 to 53 and col. 6 lines 40 to 48), there would have been no suggestion to stray from the teachings of both Shaw et al. and MacDonald et al. in relation to this process, by expressly converting all of the rib

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material into insulating material, whereby this rib material represents the entire material between the trenches, and finally forms the exclusive mechanical connection of the functional structure to the substrate in which it was formed. Both Shaw et al. and MacDonald et al. require the connecting frame or ribs to include both converted oxide isolating segments as well as non-converted conductive material segments. For these reasons, the present invention of claim 1 is not anticipated and would not have been obvious over the prior art. The dependent claims are patentable already due to their dependence. The Examiner is respectfully requested to withdraw the anticipation rejection applying MacDonald et al.

- 7) Referring to pages 5 and 6 of the Office Action, the rejection to claims 1 to 3 and 7 as anticipated by US Patent 5,506,175 (Zhang et al.) is respectfully traversed.

Important aspects of present independent claim 1 have been discussed above.

In contrast to the present invention, the method of Zhang et al. does not involve completely converting the entire rib, which represents the material remaining entirely between the trenches, but rather involves only forming isolating segments having thin cross-sections in silicon beams of which the other portions remain at least partly conductive silicon material (col. 2 lines 4, 10 and 26 to 29; col. 3 lines 1 to 32). Just like the Shaw et al. and MacDonald et al. patents, this Zhang et al. patent includes similar teachings and also develops the SCREAM process (col. 2 line 25, col. 4 line 10). Note also, that the



Shaw et al., MacDonald et al. and Zhang et al. patents share overlapping inventors, and the same assignee, and patent issuance dates in 1995 to 1997.

In this Zhang et al. patent, it is also clear that the interconnect system of beams merely includes insulating segments between adjacent conductive segments, and this is a specific purpose of the disclosed method (col. 5 lines 1 to 14). The "Cross-Section B" shown in Fig. 4 of Zhang et al., represents the thin portions or segments of the frame beams, while the "Cross-Section A" shown in Fig. 4 represents the thicker portions of the frame beams, which are not completely converted to insulating material but rather purposely retain a conductive silicon core. Fig. 3 of Zhang et al. shows where the Cross-Sections A and B are taken (see upper center area of Fig. 3). In any event, this makes clear that not the entire rib between adjacent trenches is converted to silicon, directly contrary to the presently claimed invention.

Further, the beams are secured at their outer ends to silicon-on-insulator (SOI) connecting structures, which allow electrical connections to be made to the beams from external circuitry (col. 7 lines 11 to 15). Therefore, it is absolutely necessary that the beams themselves must also include conductive portions. That is directly contrary to the requirements of present claim 1.

Therefore, the invention of present claim 1 is not anticipated, and also would not have been obvious. The dependent claims are patentable already due to their dependence. The

Examiner is respectfully requested to withdraw the anticipation rejection applying Zhang et al.

- 8) Referring to pages 7 and 8 of the Office Action, the rejection of claims 8 and 9 as obvious over Zhang et al. in view of Shaw et al. is respectfully traversed. Claims 8 and 9 depend from claim 1, which has been discussed above in comparison to both Zhang et al. and Shaw et al. For the reasons discussed above, Shaw et al. and Zhang et al., even when considered together, would have given no motivation or suggestion toward the present inventive method. Instead both of these references teach directly away from the present invention by requiring portions of a frame beam or rib to remain unconverted silicon, rather than converting all of the entire rib material to insulating material. Therefore, even a consideration of both references together still would not have suggested the directly contrary features of the present invention that have been discussed above. Thus, independent claim 1 and its dependent claims 8 and 9 would not have been obvious over a combined consideration of the two references. The Examiner is respectfully requested to withdraw the obviousness rejection applying Zhang et al. in view of Shaw et al.
- 9) New independent claim 10 is also patentably distinguishable over the prior art for reasons similar to those discussed above in comparison to the three applied references. For example, claim 10 recites a step of "completely converting all of said semiconductor material of said rib to said insulating material".

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As discussed above, the three references do not disclose such a step, but instead purposely disclose a step of converting only some of the semiconductor material of the rib to insulating material. Claim 10 further recites forming an electrically insulating structure between the first and second trenches (from the converted semiconductor material of the rib), and additionally this electrically insulating structure extends continuously along at least one side of the trenches by converting the semiconductor material along the at least one side of the trenches to an insulating material. Furthermore, claim 10 recites a step of forming a micromechanical functional structure in an additional trench in the substrate adjacent to the insulating structure such that the insulating structure extends between the additional trench and the first and second trenches, between which the rib was formed. This further distinguishes the invention of claim 10 from the prior art references, in which the alleged functional structure was formed between the same two trenches between which the alleged rib was formed. The references did not disclose such a process step of present claim 10. The new dependent claims 11 to 20 recite additional features that further distinguish the invention from the prior art. The Examiner is respectfully requested to consider these additional features when further examining this application. Favorable consideration of the new claims 10 to 20 is respectfully requested.

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- 10) Favorable reconsideration and allowance of the application, including all present claims 1 to 3 and 7 to 20, are respectfully requested.

Respectfully submitted,

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Enclosures:  
Transmittal Cover Sheet  
Term Extension Request  
Form PTO-2038

By Walter F. Fasse  
Walter F. Fasse  
Patent Attorney  
Reg. No.: 36132  
Tel. 207-862-4671  
Fax. 207-862-4681  
P.O. Box 726  
Hampden, ME 04444-0726

CERTIFICATE OF FAX TRANSMISSION:

I hereby certify that this correspondence with all indicated enclosures is being transmitted by telefax to (571) 273-8300 on the date indicated below, and is addressed to: COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450.

Walter F. Fasse 5/21/10  
Name: Walter F. Fasse - Date: May 21, 2010